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DINAMIKA UVOĐENJA NISKOSUMPORNIH GORIVA NA TRŽIŠTE REPUBLIKE HRVATSKE

Sažetak

Potreba za očuvanjem čovjekove okoline u posljednjem desetljeću ima sve veći utjecaj i na naftnu industriju, a očituje se kroz sve strože zahtjeve za kvalitetom goriva. U radu je prikazan značaj utjecaja emisija štetnih ispušnih plinova iz motornih vozila u Hrvatskoj i u zemljama Europske unije (15 zemalja članica do 2004. godine).

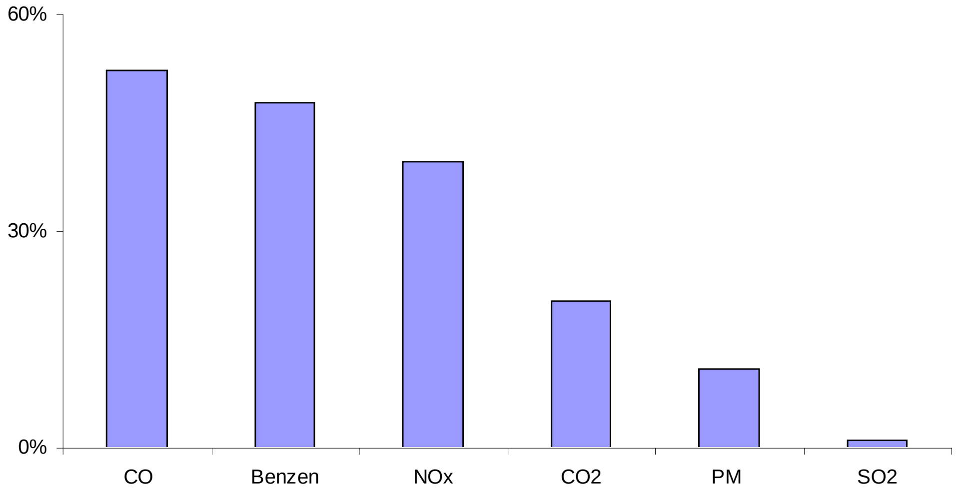
Osim utjecaja emisija iz prometa u radu je dan usporedni prikaz trendova promjene štetnih emisija u Hrvatskoj i zemljama članicama Europske unije, te utjecajni čimbenici, kao što su tehnološki razvoj motornih vozila, struktura motornog fonda i dr.

Uvod

Razmatrajući udio emisije pojedinih ispušnih plinova iz prometa u ukupnoj emisiji štetnih plinova (slika 1) vidljiv je vrlo veliki značaj ugljičnog monoksida, benzena i dušičnih oksida. Za razliku od emisije ostalih ispušnih plinova, gorivo ima izravan utjecaj jedino na razinu emisije benzena, pa otuda i dolaze zahtjevi za smanjenjem najveće dopuštene granice benzena u gorivima. Za razliku od benzena, najveći potencijal za redukciju emisije ostalih ispušnih plinova iz prometa predstavlja razvoj automobilske tehnologije. Utjecaj prometa na ukupnu razinu emisije sumpornog dioksida je gotovo beznačajan u odnosu na utjecaj na emisije ostalih ispušnih plinova, te možemo zaključiti kako zahtjev za smanjenje razine sumpora u motornim gorivima nije izravna posljedica nastojanja smanjenja emisije sumpornog dioksida.

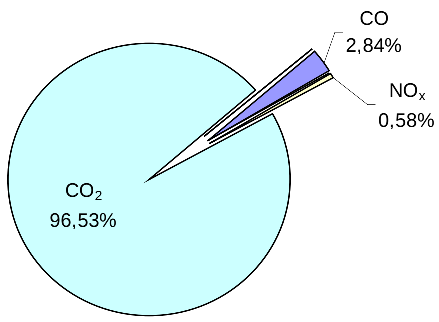
Veliki napori automobilske industrije koji se ulažu u pravcu smanjenja emisije ugljičnog dioksida posljedica su činjenice da je emisija ugljičnog dioksida u najvećoj mjeri povezana s potrošnjom goriva, čijim smanjenjem se svakako utječe i na emisije ostalih štetnih ispušnih plinova. Međutim, kada je riječ o utjecaju prometa na ukupnu emisiju štetnih plinova, važno je uočiti da, iako udio emisije ugljičnog dioksida iz prometa u ukupnoj emisiji iznosi samo 20%, on je u ukupnoj emisiji štetnih ispušnih plinova iz prometa najzastupljeniji s gotovo 97% (slika 2). Osim ugljičnog dioksida relativno značajnu ulogu u emisiji iz prometa imaju još ugljični monoksid i dušični oksidi. S obzirom na štetnost ugljičnog monoksida i dušičnih oksida neupitna je potreba redukcije navedenih emisija, a kako razina njihove emisije ovisi o uvjetima izgaranja goriva, koje diktiraju tehničke izvedbe motora, jasan je utjecaj automobilske industrije na smanjenje njihove emisije.

Slika 1: Udio emisije iz prometa u ukupnoj emisiji
Figure 1: Traffic-induced emission share in total emission



/Benzene/

Slika 2: Udio emisije pojedinih ispušnih plinova u ukupnoj emisiji iz prometa
Figure 2: Share of individual exhaust gas emission in total traffic-generated emission

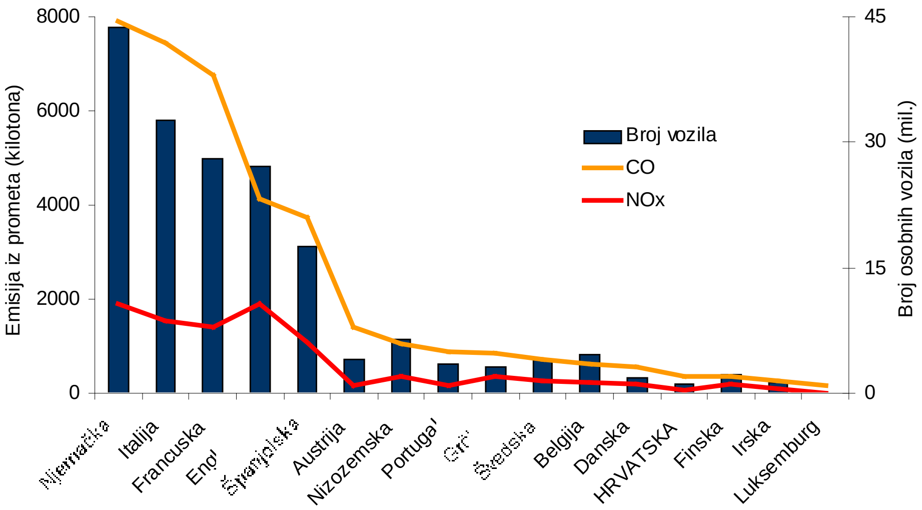


Promet i emisija štetnih plinova

Emisija štetnih ispušnih plinova iz prometa u najvećoj mjeri ovisi o broju vozila, intenzitetu prometa i starosnoj strukturi vozila na pojedinom tržištu (slika 3).

Analiza ovisnosti razine emisije promatranih ispušnih plinova o broju osobnih vozila ukazuje na postojanje korelacije, ali mogu se također vidjeti i određena odstupanja, koja su posljedica utjecaja intenziteta prometa i strukture motornog fonda.

Slika 3: Ukupan broj osobnih vozila i emisija CO i NO_x iz prometa u zemljama Europske unije i Republike Hrvatske
Figure 3: Total number of passenger vehicles vs traffic-induced CO and NO_x emission in countries of European Union and in Croatia

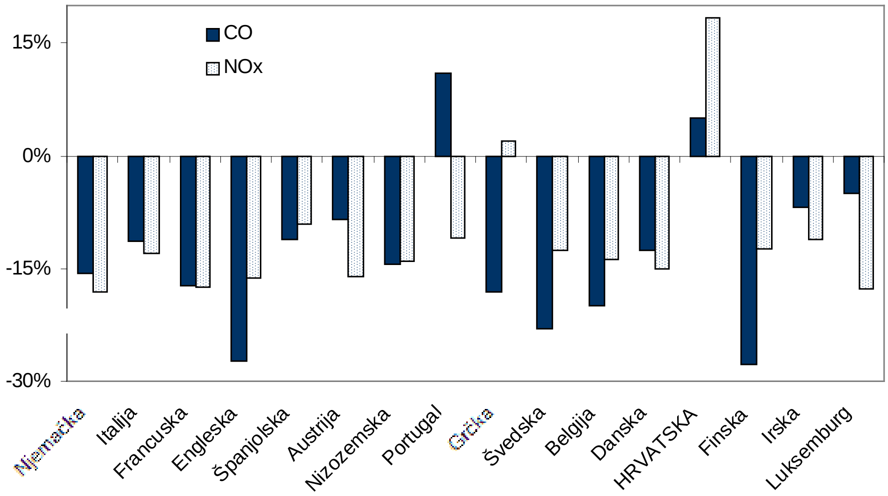


/Emission from traffic (kilotons), Number of passenger vehicles (mln), Number of vehicles

Germany, Italy, France, England, Spain, Austria, The Netherlands, Portugal, Greece, Sweden, Belgium, Denmark, CROATIA, Finland, Ireland, Luxembourg/

Osim razine emisije ispušnih plinova zanimljivo je analizirati promjene koje se u posljednjih nekoliko godina događaju (slika 4). Uspoređujući emisiju ispušnih plinova u EU 2000. godine u odnosu na 1995. godinu, usprkos stalnom porastu broja motornih vozila i povećanju intenziteta prometa, vidimo trend smanjenja emisije ugljičnog monoksida i dušičnih oksida. U usporedbi s EU u Hrvatskoj se bilježe negativni trendovi odnosno porast emisije promatranih ispušnih plinova, a osim Hrvatske ovakvi trendovi u manjoj mjeri bilježe se u Portugalu i Grčkoj. Kao i u EU i u Hrvatskoj se bilježi stalni rast broja motornih vozila, kao i povećanje intenziteta prometa, ali ono u čemu je Hrvatska različita od EU, a što izravno utječe na povećanje emisije ispušnih plinova jest starosna struktura motornog fonda.

Slika 4: Promjene emisije CO i NOx u zemljama Europske unije i Republike Hrvatske za razdoblje od 1995. do 2000. godine
Figure 4: Changes in the emission of CO and NOx in European Union countries and in Croatia in the 1995 –2000 period



/Germany, Italy, France, England, Spain, Austria, The Netherlands, Portugal, Greece, Sweden, Belgium, Denmark, CROATIA, Finland, Ireland, Luxembourg/

Razvoj automobilske tehnologije

Najznačajniji utjecaj na smanjenje emisije ispušnih plinova svakako ima razvoj automobilske tehnologije. U tom smislu razvoj, odnosno konstrukcijske promjene koje su se dogodile, možemo razmatrati u tri osnovna područja:

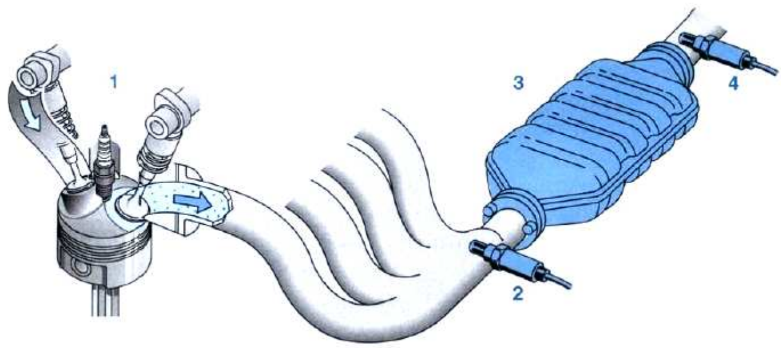
- priprema gorive smjese,
- sustavi kontrole rada motora,
- sustavi za obradu ispušnih plinova.

Zadovoljenje sve strožih zahtjeva za smanjenje emisije ispušnih plinova danas je gotovo nezamislivo bez korištenja sofisticiranih sustava za dijagnostiku rada motora (OBD), koji su omogućili značajna poboljšanja u smislu kontrole i regulacije procesa izgaranja gorive smjese, kao i kontrole rada sustava za obradu ispušnih plinova.

Primjena sustava za dijagnostiku rada motora definirana je homologacijskim propisima. Za benzinske motore prvi put se pojavljuje u SAD-u 1994., dok se u Europi primjenjuju od 2000. godine što je povezano sa stupanjem na snagu zahtjeva za emisijom ispušnih plinova EURO III. Sukladno Naredbi o homologaciji vozila s obzirom na emisiju štetnih spojeva u skladu s gorivom koje upotrebljava motor (NN 94/02) u Hrvatskoj sva nova vozila moraju biti opremljena OBD sustavom od 1.04. 2003. godine. Za dizelove motore zahtjevi za primjenom OBD sustava su nešto blaži, odnosno stupaju na snagu nešto kasnije, nego za benzinske motore. Te se u Europi primjenjuju od 2003., a u Hrvatskoj od 1.04.2004. godine.

Da bi OBD sustav funkcionirao, zahtijeva najmanje dvije lambda sonde, od kojih je jedna upravljačka sonda koja temeljem utvrđenog sadržaja kisika u ispušnim plinovima preko računala upravlja procesom ubrizgavanja goriva kako bi se izgaranje odvijalo u projektiranim granicama (slika 5). Kontrolna lambda sonda svoju funkciju ostvaruje na način da temeljem utvrđenog sadržaja kisika nakon katalizatora daje informaciju o učinkovitosti katalizatora. Učinkovitost katalizatora prati se preko njegove sposobnosti "pohranjivanja" kisika. Tako je za potpuno novi katalizator količina kisika na izlazu iz katalizatora znatno manja nego na ulazu jer se kisik troši na oksidacijske procese u samom katalizatoru. Mjerenjem razlike kisika ispred i iza katalizatora utvrđuje se stupanj potrošenosti katalizatora.

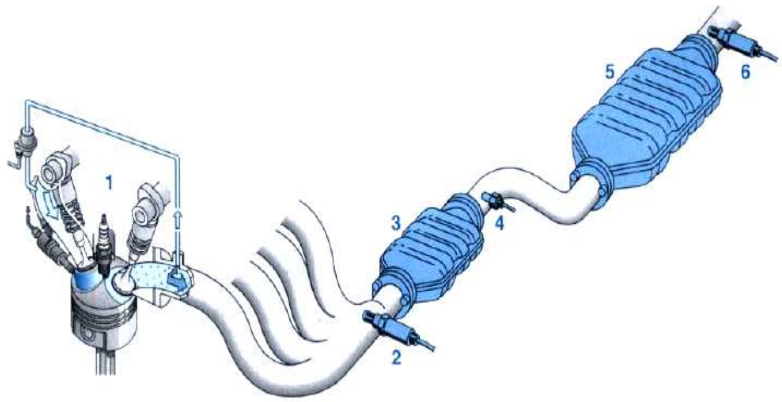
Slika 5: Izvedba sustava za obradu ispušnih plinova, koji predstavlja preduvjet za primjenu OBD sustava
Figure 5: System for exhaust gases treatment as prerequisite for applying EOD system



1. motor	1. Engine
2. upravljačka lambda sonda	2. Guiding *lambda* probe
3. katalitički pretvarač	3. Catalytic converter
4. kontrolna lambda sonda	4. Control lambda probe

Danas najzastupljeniji motori s neizravnim ubrizgavanjem opremljeni katalizatorom trostrukog djelovanja i sustavima za dijagnostiku rada motora omogućuju zadovoljenje EURO III zahtjeva za emisiju ispušnih plinova, a pri tome zahtijevaju motorne benzine sa sadržajem sumpora do najviše 150 ppm. Od 01.01.2005. godine na snagu stupa novi EURO IV zahtjev za emisijom ispušnih plinova, a smanjivanje sadržaja sumpora u gorivu na razinu od najviše 50 ppm ovim motorima omogućava zadovoljenje i EURO IV zahtjeva za sve kontrolirane ispušne plinove osim za emisiju ugljičnog monoksida.

Slika 6: Sustav za obradu ispušnih plinova korišten kod motora s izravnim ubrizgavanjem goriva
Figure 6: System for exhaust gases treatment used for direct fuel injection engines



1- Motor	1. Engine
2- Upravljačka lambda sonda	2. Steering *lambda* probe
3- Katalitički pretvarač trostrukog djelovanja	3. Triple-action catalytic converter
4- Temperaturna sonda	4. Temperature probe
5- NOx akumulatorski katalitički pretvarač	5. NOx battery catalytic converter
6- Kontrolna lamda sonda	6. Control *lambda* probe

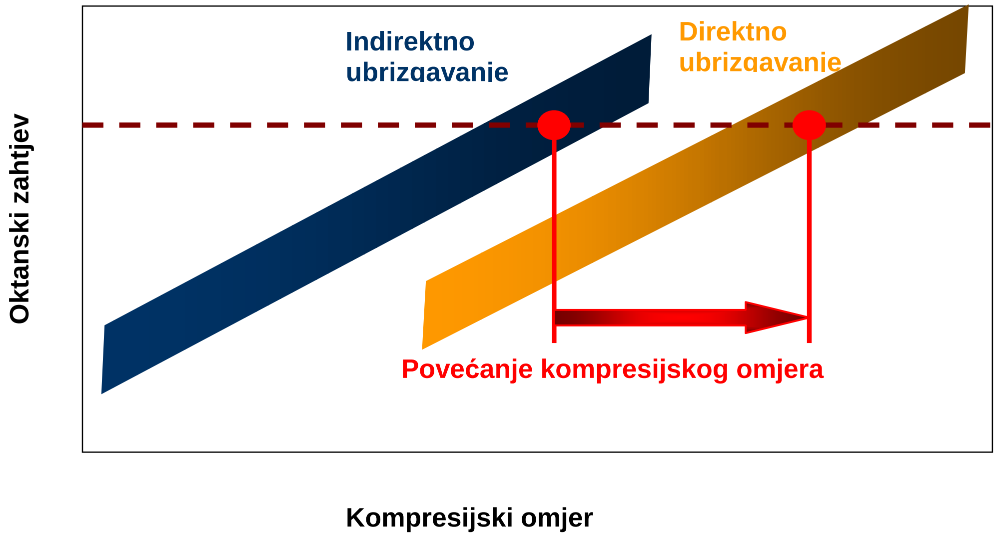
Rješenje za značajniju redukciju emisije ugljičnog monoksida, kao i ugljičnog dioksida automobilska industrija pronašla je u razvoju novih tehnologija pripreme gorive smjese, a motori s izravnim ubrizgavanjem u tom pravcu su donijeli velika poboljšanja i otvorili nove mogućnosti. Osnovna značajka motora s izravnim ubrizgavanjem je mogućnost prilagođavanja režima rada ovisno o opterećenju motora na način optimiranja utjecaja na okoliš. Motor u režimu rada koji odgovara nižim i srednjim opterećenjima radi s ultra siromašnom smjesom goriva i zraka, čega je posljedica smanjenje potrošnje goriva, a samim tim i emisije ispušnih plinova. Tijekom rada motora u području visokih opterećenja motor radi sa stehiomerijskim omjerom gorive smjese.

Rad motora s izravnim ubrizgavanjem goriva u području ultra siromašne gorive smjese ima za posljedicu povećanje emisije dušičnih oksida, koju nije moguće reducirati katalizatorom trostrukog djelovanja, pa se zbog toga u ispušnom sustavu dodaje još jedan NOx akumulatorski katalizator ili tzv. NOx apsorber (slika 6), a često se koristi i sustav povrata ispušnih plinova u usisnu granu ili tzv. EGR.

NOx akumulatorski katalizatori vrlo su osjetljivi na sadržaj sumpora u gorivu, a povećanje razine sumpora smanjuje mogućnosti akumulacije dušičnih oksida, tako da povećanje sumpora znatno smanjuje vrijeme rada nakon kojeg je potrebna desulfurizacija katalizatora.

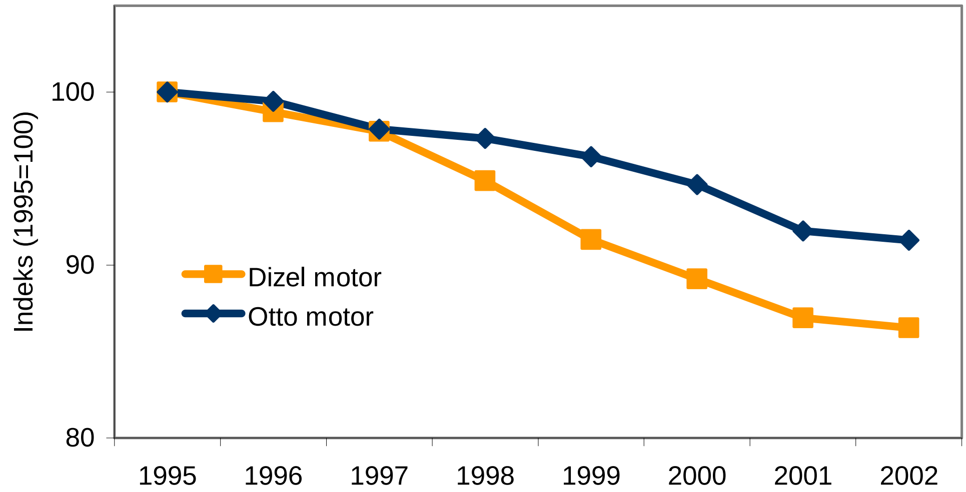
Osim rada s ultra siromašnom smjesom prednost motora s izravnim ubrizgavanjem je i njihov niži oktanski zahtjev, što zadržavanjem oktanskog zahtjeva motora na dosadašnjoj razini omogućuje povećanje kompresijskog omjera čime se dodatno povećava iskoristivost motora odnosno smanjuje specifična potrošnja goriva (slika 7), a samim tim i emisija ugljikovih oksida.

Slika 7: Oktanski zahtjev u ovisnosti o načinu ubrizgavanja goriva
Figure 7: Octane requirement in dependence of fuel injection manner

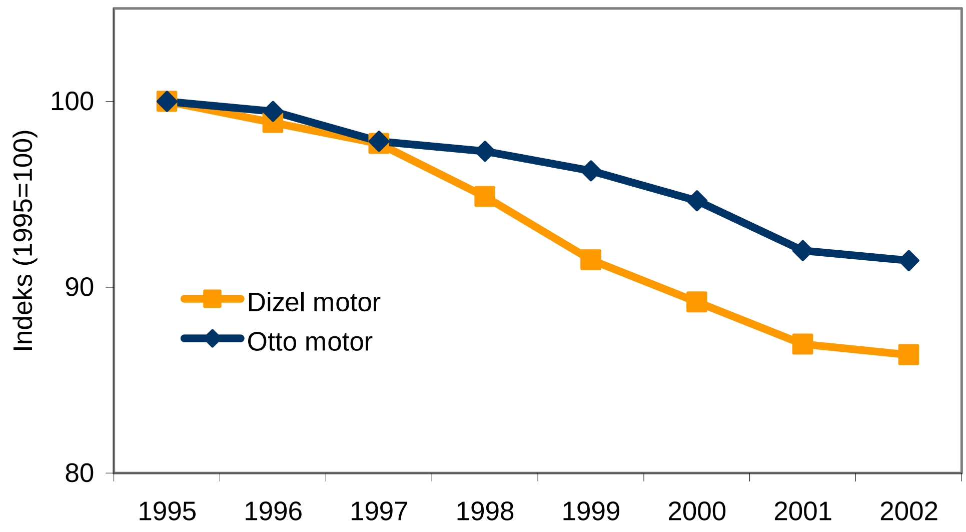


Octane requirement; Indirect injection; Direct injection; Compression ratio increase

Slika 8: Promjena emisije CO_2 novih motornih vozila
Slika 8: Change in CO_2 emission provided by new vehicles



Slika 9: Promjena potrošnje goriva novih motornih vozila
Figure 9: Change in fuel consumption provided by new vehicles



Razvoj automobilske tehnologije u razdoblju od 1995. godine doveo je do stalnog smanjenja emisije ugljičnog dioksida, koji je najzastupljeniji među štetnim ispušnim plinovima iz vozila. Na slici 8 također je vidljivo da razvoj dizelovih motora omogućuje značajnija smanjenja emisije, te im u tom smislu daje prednost u odnosu na benzinske motore.

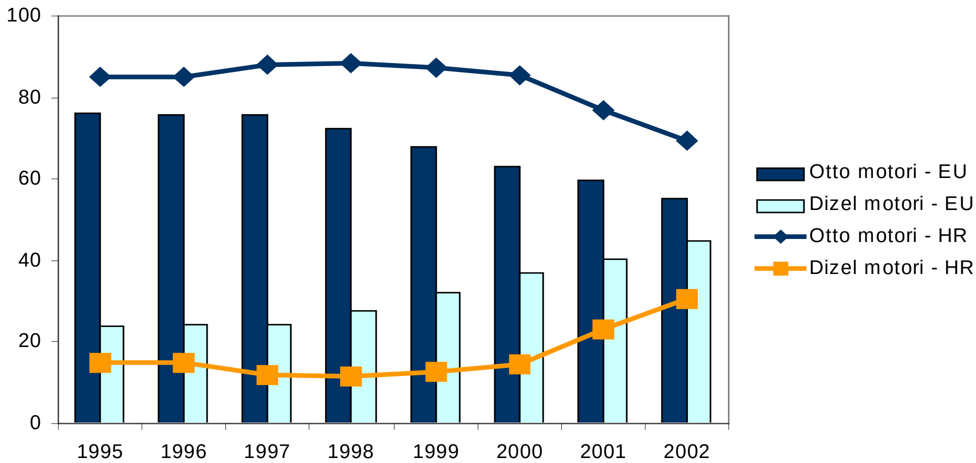
Emisija ugljičnog dioksida izravno je povezana s potrošnjom goriva pa je tako u razdoblju od 1995. godine vidljivo i stalno smanjenje potrošnje goriva, koje je također nešto veće kod dizelovih nego kod benzinskih motora (slika 9). Uočljiv je skok sa 1998. na 1999. godinu kada se na tržištu značajnije pojavljuju *common rail* sustavi kod dizelovih motora. Osim prednosti u potrošnji goriva dizelovi motori su u određenoj prednosti i što se tiče značajnijeg poboljšanja voznih osobina.

Struktura motornog fonda

Ovakvi trendovi bržeg razvoja dizelovih motora u zemljama EU imaju posljedicu sve većeg udjela dizelovih motora u ukupnom broju novoregistriranih osobnih vozila, pa je tako udio dizelovih motora od 24% 1995. godine rastao do 45% u 2002. godini.

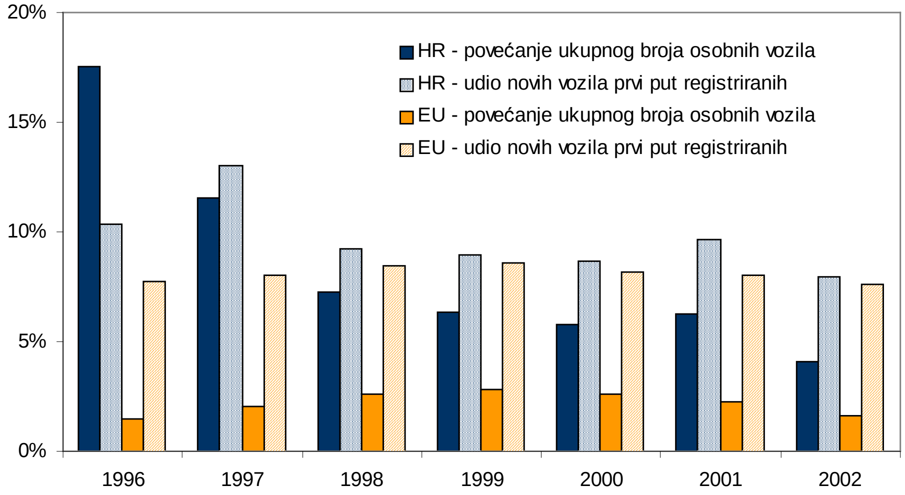
Ovakav trend vidljiv je i u Hrvatskoj, iako je u Hrvatskoj udio benzinskih motora nešto viši nego u EU, gdje se broj novoregistriranih osobnih vozila s dizelovim i benzinskim motorom gotovo izjednačio (slika 10).

Slika 10: Zastupljenost pogonskih agregata
Figure 10: Representation of drive engines



Za razliku od zemalja EU u Hrvatskoj je u razdoblju od 1995. do 2000. godine povećana ukupna količina emisije ispušnih plinova, a budući da se u Hrvatskoj kao i u zemljama EU broj vozila iz godine u godinu povećava, te uzimajući u obzir velik utjecaj automobilske tehnologije na razinu emisije, može se zaključiti da je trend povećanja emisije ispušnih plinova u Hrvatskoj posljedica u najvećoj mjeri starosne strukture motornog fonda. Tako se iz prikaza ukupnog povećanja broja osobnih vozila (slika 11) i broja novih vozila u Hrvatskoj vidi da je do 1997. godine ukupno povećanje broja vozila veće od broja novih vozila, što je posljedica uvoza starijih rabljenih vozila, dok se od 1997. godine ovakav trend mijenja i ulaz novih vozila na tržište je veći od ukupnog povećanja broja vozila, te se motorni fond počinje obnavljati. Usporedimo li ove podatke s podacima za EU, vidimo da je u zemljama EU ulaz novih vozila znatno veći od ukupnog povećanja motornog fonda.

Slika 11: Godišnja stopa porasta broja osobnih vozila
Figure 11: Annual increase rate in the number of passenger vehicles

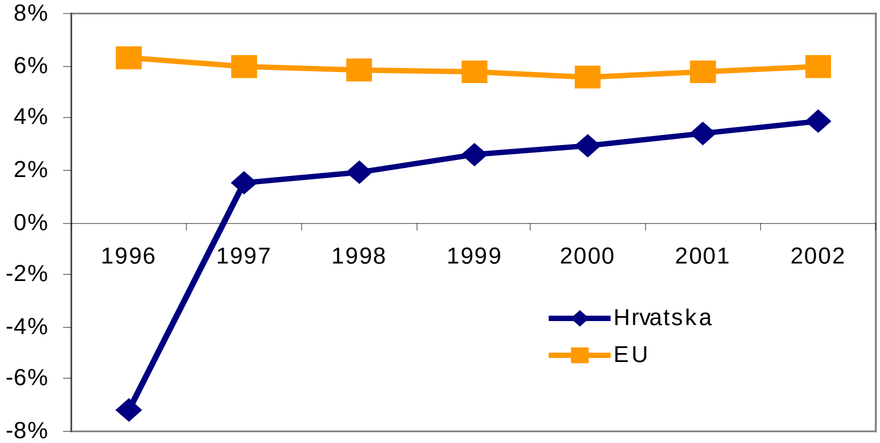


/HR - increase in the total number of passenger vehicles
HR - share of new vehicles registered for the first time
EU - increase in the total number of passenger vehicles
EU - share of new vehicles registered for the first time/

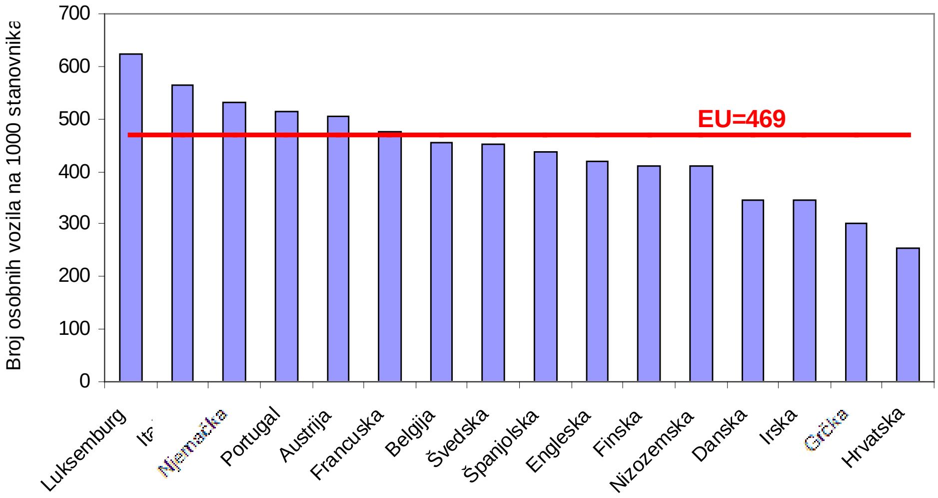
Iz navedenog se može zaključiti kako je godišnja stopa obnove motornog fonda u EU viša od stope obnove motornog fonda u Hrvatskoj, a kreće se oko 6% godišnje za EU, dok je za Hrvatsku u stalnom porastu i već dostiže stopu od 4% (slika 12).

Niža stopa obnove motornog fonda u Hrvatskoj može se tumačiti uvjetno rečeno glađu tržišta za novim osobnim vozilima. Uspoređujući zasićenost tržišta osobnim automobilima u EU i Hrvatskoj vidimo da je Hrvatska na razini od 255 vozila na 1000 stanovnika dok je prosjek EU gotovo dvostruko viši na razini od 469 vozila na 1000 stanovnika.

Slika 12: Godišnja stopa obnove motornog fonda
Figure 12: Annual rate of vehicle pool renewal



Slika 13: Broj osobnih vozila na 1000 stanovnika
Figure 13: Number of passenger vehicles per 1000 inhabitants



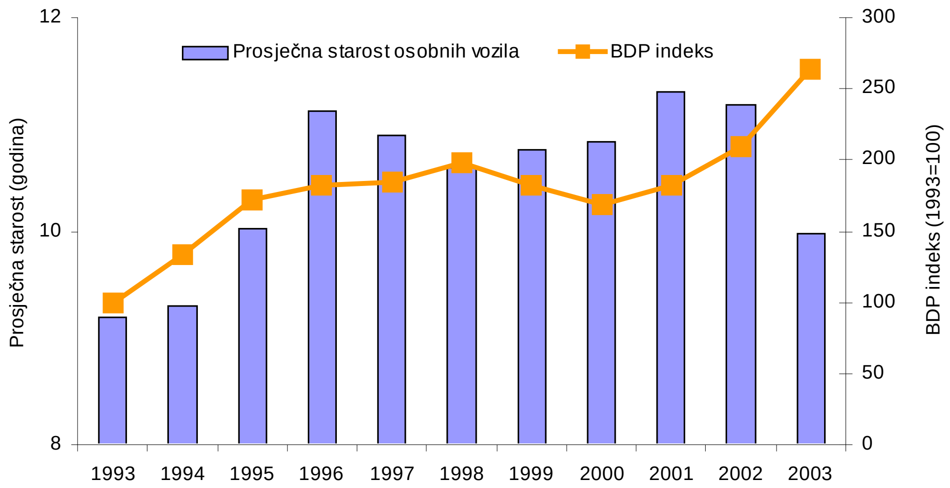
/Number of passenger vehicles per 1000 inhabitants

Luxembourg, Italy, Germany, Portugal, Austria, France, Belgium, Sweden, Spain, England, Finland, The Netherlands, Denmark, Ireland, Greece, Croatia/

Analizom promjene prosječne starosti osobnih vozila u Hrvatskoj za razdoblje od 1993. do 2002. godine može se uočiti do 1996. godine ubrzano povećanje prosječne starosti osobnih vozila, odnosno, kako je već pokazano, Hrvatska je imala negativnu stopu obnove motornog fonda, a nakon 1996. dolazi do promjene trenda.

Uspoređujući prosječnu starost osobnih vozila s bruto društvenim proizvodom može se utvrditi određena korelacija, a može se uočiti da porast bruto društvenog proizvoda utječe na smanjenje prosječne starosti osobnih vozila i obrnuto. Za razdoblje do 1996. godine porastom BDP raste i prosječna starost vozila zbog visoke stope ulaza rabljenih vozila uglavnom iz zapadne Europe.

Slika 14: Starosna struktura motornog fonda u Republici Hrvatskoj
Figure 14: Age structure of vehicle pool in Croatia

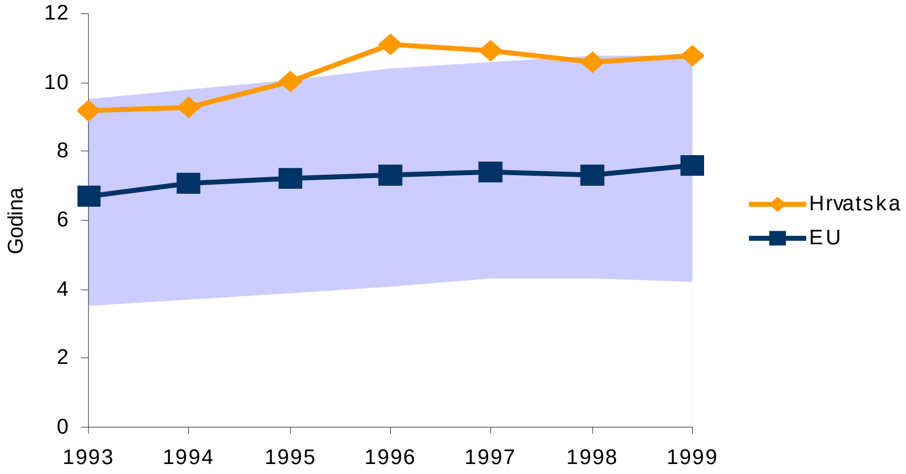


/Average age (years) GSP index/

Inače, važno je napomenuti da je i u zemljama EU, bez obzira na stopu obnove motornog fonda od 6% godišnje, prisutan trend starenja motornog fonda, ali znatno sporije nego u Hrvatskoj, a prosjek EU kreće se oko 7 godina, dok je u Hrvatskoj oko 11 godina. Promatrajući raspon prosječne starosti osobnih vozila u zemljama EU uočavaju se krajnje vrijednosti za Portugal gdje promjena starosne strukture osobnih vozila odgovara vrijednostima za Hrvatsku i s druge strane Luksemburg gdje je prosječna starost osobnih vozila najniža u EU oko 4 godine.

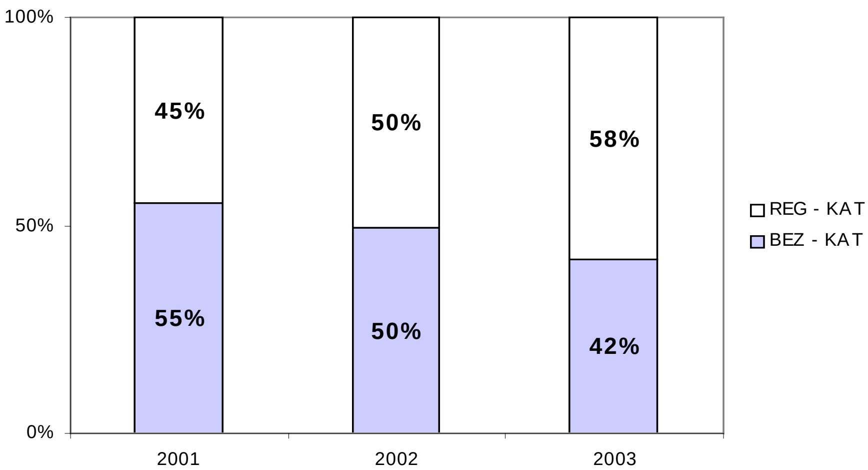
Osim do sada pokazanog stanja motornog fonda u Hrvatskoj, a vezano za utjecaj na emisiju ispušnih plinova, važno je napomenuti da se odnos benzinskih motora sa i bez katalizatora stalno mijenja. Tako je od 2001. godine kada je udio vozila s katalizatorom iznosio 45% do 2003. godine njihov udio porastao na 58%.

Slika 15: Starosna struktura motornog fonda u zemljama EU i Republici Hrvatskoj
Figure 15: Age structure of vehicle pool in countries of EU and in Croatia



/Year/

Slika 16: Udio osobnih vozila s benzinskim motorom ovisno o opremljenosti katalitičkim pretvaračem
Figure 16: Share of passenger vehicles with gasoline engine depending on whether they have catalytic converters or not



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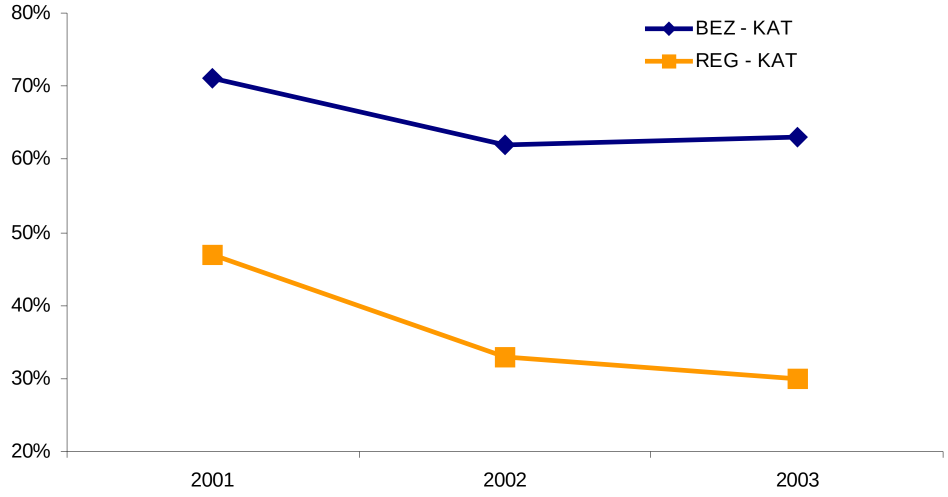
Od 2001. godine u sklopu tehničkog pregleda vozila provodi se i EKO test za benzinske motore, a rezultati pokazuju da se broj neispravnih vozila na EKO testu iz godine u godinu smanjuje, posebno za vozila s katalizatorom, gdje se bilježi pad sa 47% neispravnih vozila iz 2001. godine na 30% u 2003. godini. Kod benzinskih motora bez katalizatora s obzirom da se radi o značajno starijim vozilima, situacija je mnogo lošija, a od 71% neispravnih vozila u 2001. godini došlo se do razine od 63% u 2002. godini, a tijekom 2003. godine nije došlo do značajnijih poboljšanja. Budući da je EKO test od 01.10.2004. godine postao obveza, situacija će se znatno popraviti, a isto tako očekuje se da će EKO test ubrzati pomlađivanje motornog fonda u Hrvatskoj.

Slika 17: Udio neispravnih osobnih vozila s benzinskim motorom tijekom provedbe EKO testa
Figure 17: Share of passenger vehicles with gasoline engine failing during the performance of the ECO test



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ZAKLJUČAK

1. Značajnije smanjenje emisije ispušnih plinova moguće je ostvariti isključivo razvojem novih automobilskih tehnologija.
2. Sve stroži zahtjevi za kvalitetom goriva posljedica su povećane osjetljivosti sustava za obradu ispušnih plinova na pojedine fizikalno kemijske značajke goriva.
3. Starosna struktura motornog fonda u najvećoj mjeri ograničava mogućnosti smanjenja emisije ispušnih plinova.
4. U Hrvatskoj s obzirom na trenutačno stanje i trendove promjena osnovnih značajki motornog fonda, uz osiguravanje goriva kvalitete sukladne važećim europskim specifikacijama, postoji opravdanost zadržavanja u prometu goriva niže kvalitete u količini ovisno o potrebama tržišta.

DYNAMICS OF INTRODUCING LOW-SULPHUR FUELS INTO CROATIAN MARKET

Abstract

The need for environmental protection has in the past decade had a constantly growing impact also on the oil industry, manifested through increasingly stringent fuel quality requirements. The paper presents the significance of harmful automotive exhaust gas emission impact in Croatia and in the European Union countries (15 member countries by 2004).

Apart from the impact of traffic-generated emission, the paper also presents a comparative presentation of harmful emission change trends in Croatia and in the European Union member countries, as well as influential factors, such as technological development of motor vehicles, motor pool structure, etc.

Introduction

Considering the emission share of individual traffic-induced exhaust gases in total emission of noxious gases (Figure 1), one may observe a very high significance of carbon monoxide, benzene and nitrogen oxides. Unlike the emission of other exhaust gases, fuel has a direct impact only on benzene emission level, hence the requirements for reducing the highest permissible limit of its fuel share. Unlike benzene, the highest potential for reducing the emission of other traffic-induced exhaust gases lies in automotive technology development. The impact of traffic on the total level of sulphur dioxide emission is practically insignificant with respect to its impact on the emission of other exhaust gases, so that we may conclude that the requirements for reducing sulphur level in motor fuels are not a direct consequence of efforts to reduce the emission of sulphur dioxide.

Great efforts of the automotive industry invested in reducing the emission of carbon dioxide result from the fact that the carbon dioxide emission is to the highest possible extent associated with fuel consumption, the reduction of which definitely impacts also the emissions of other noxious exhaust gases. However, when it comes to the impact of traffic on total emission of noxious gases it is important to observe that, although the emission share of traffic-induced carbon dioxide in total emission amounts to only 20%, in the total emission of traffic-induced noxious exhaust gases it has the highest share of nearly 97% (Figure 2). Apart from carbon dioxide, a relatively considerable role in traffic-induced emission is that of carbon monoxide and nitrogen oxides. Given the noxious character of carbon monoxide and nitrogen oxides, it goes without saying that the said emissions need to be reduced, and, since their emisson level is dependent on fuel combustion conditions, dictated by technical engine designs, the impact of automotive industry on their emission reduction is clear.

Traffic and the Noxious Gases Emission

The emission of traffic-induced noxious exhaust gases is to the largest extent dependent on the number of vehicles, traffic intensity and age structure of vehicles on a given market (Figure 3).

An analysis of dependence of the emission level of the exhaust gases under observation on the number of passenger vehicles points to the existence of a correlation, but certain aberrations may also be observed, resulting from the impact of traffic intensity and vehicle pool structure.

Apart from the exhaust gas emission level it is also interesting to analyze changes that have been occuring over the past few years (Figure 4). Thus, by comparing emission of exhaust gases in EU in 2000 with regard to 1995, in spite of a constant increase in the number of motor vehicles and the increase of traffic intensity, we may observe a reduction trend of carbon monoxide and nitrogen oxides emission. In comparison with the EU, Croatia is recording negative trends i.e. increase in the emission of the observed exhaust gases, while, apart from Croatia, such trends were to a somewhat lesser extent recorded also in Portugal and Greece. Same as in EU, in Croatia there is a constant increase in the number of motor vehicles as well as in traffic intensity. However, what differs Croatia from the EU, directly impacting increased emission of exhaust gases, is the vehicle pool age structure.

Figure 4: Changes in the emission of CO and NOx in European Union countries and in Croatia in the 1995 - 2000 period.

Development of Automotive Technology

The most significant impact on the exhaust gas emission reduction is definitely that of the automotive technology development. In this sense, the development i.e. design changes that have ocurred may be considered through three basic areas:

- preparation of the fuel blend
- engine operation control systems
- exhaust gas processing systems.

The meeting of increasingly stringent requirements for reducing exhaust gas emission is today almost inconceivable without the use of sophisticated systems for engine operation diagnostics (EOD), enabling considerable improvements in the sense of control and regulation of the fuel blend combustion process, as well as operation control of the exhaust gas processing system.

Application of the system for engine operation diagnostics has been defined by homologation regulations. For gasoline engines, it has appeared for the first time in the United States in 1994, while in Europe it has been applied since 2000, connected with the entry into force of the requirement for exhaust gas emission EURO III. In keeping with the Order on the Homologation of Vehicles with Regard to Noxious Gases Emission Given the Fuel Used by the Engine (NN 94/02), in Croatia all new vehicles must be equipped by EOD system as of 1 April 2003. For diesel engines, requirements for the application of EOD system are somewhat milder i.e. they enter into force somewhat later than for gasoline engines. In Europe, they have been applied since 2003, and in Croatia since 1 April 2004.

In order to function, EOD system requires at least two *lambda* probes, one of which is the guiding probe controlling the fuel injection process based on the oxygen content in the exhaust gases established via computer so that combustion may proceed in the designed limits (Figure 5). The control lambda probe performs its function by providing information on catalytic converter efficiency based on the established oxygen content after the catalytic converter. Catalytic converter efficiency is monitored through its capacity to “store” oxygen. Thus, for a brand new catalytic converter the volume of oxygen at its output is much lower than at its input because the oxygen is spent on oxidation processes within the catalytic converter itself. By measuring the difference in oxygen level before and after the catalytic converter one may establish its worn-out condition.

Indirect injection engines which are today the most numerous, equipped with a triple-action converter and systems for engine operation diagnostics, enable the meeting of the EURO III exhaust gas emission requirement, requiring motor gasoline with a sulphur content of 150 ppm at the most. As of 01 January 2005, a new EURO IV requirement for exhaust gas emission enters into force, while lowering the fuel sulphur content to the level of 50 ppm at the most makes it possible for these engines to meet also the EURO IV requirement for all controlled exhaust gases except carbon monoxide emission.

Solution for a more considerable reduction of carbon monoxide, as well as carbon dioxide emission, has been found by the automotive industry in the development of new technologies of fuel blend preparation, while direct injection engines have brought major improvements in this sense, opening up new possibilities. The basic characteristic of direct injection engines is the possibility of adjusting the operating regime to engine load thus optimizing environmental impact. Engine in the operating regime corresponding to low and medium loads operates with an ultra lean fuel/air blend, resulting in reduced fuel consumption and hence also exhaust gas emisson. During engine's operation in the area of heavy loads, the engine operates with a stehiometric fuel blend ratio.

Operation of engine with direct fuel injection in the area of ultra lean fuel blend results in increased nitrogen oxides emission that cannot be reduced by a triple-action converter, which is why the exhaust system is added another NOx battery catalyst or the so called NOx absorber (Figure 6), while the system of returning the exhaust gases into the intake manifold or the so called EGR is also frequently used.

NOx battery converters are highly sensitive to the fuel sulphur content, while increased sulphur level reduces the possibility of nitrogen oxides accumulation. Sulphur content increase has thus considerably reduced the operation time after which converter desulphurization is required.

Apart from operation with ultra lean blend, the advantage of direct injection engines lies also in their lower octane requirement: By keeping the octane requirement on the so far level it enables increase of the compression ratio thus furtherly increasing engine efficiency i.e. reducing specific fuel consumption (Figure 7), and hence also carbon oxide emission.

Development of automotive technology in the period since 1995 has lead to a constant reduction of the carbon dioxide emission as the most frequent automotive noxious gas. Figure 8 also shows that the development of diesel engines enables considerable emission reductions, thus providing them with an advantage with regard to gasoline engines.

Carbon dioxide emission is directly associated with fuel consumption so that in the period since 1995 one may observe also a constant fuel consumption reduction, which is also somewhat higher in the case of diesel engines than in that of gasoline ones (Figure 9). One may furtherly observe the jump from 1998 to 1999 when there was a more considerable appearance of the common rail systems for diesel engines. Apart from advantages associated with fuel consumption, diesel engines also have certain advantages in terms of more considerable improvement of the driveability performances.

The Vehicle Pool Structure

Such trends of a faster development of diesel engines in EU countries have resulted in increasing share of diesel engines in the total number of newly registered passenger vehicles, so that the share of diesel engines has gone up from 24% in 1995 to 45% in 2002.

Such a trend may also be observed in Croatia, although in Croatia the share of gasoline engines is somewhat higher than in the EU, where the number of newly registered passenger vehicles with diesel and gasoline engines is practically even (Figure 10).

Unlike in the EU countries, in Croatia, in the 1995-2000 period there has been an increase in the total volume of exhaust gases emission. Since in Croatia, same as in the EU countries, the number of vehicles is increasing year in year out, and taking into account the major impact of automotive technology on emission level, one may conclude that the increase trend of exhaust gases emission in Croatia is to the largest extent the result of the vehicle pool age structure. Thus from the review of the total increase in the number of passenger vehicles (Figure 11) and the number of new vehicles in Croatia it may be seen that up to 1997 the total increase in the number of vehicles was higher than that of new vehicles, resulting from the import of older used vehicles, while since 1997 the trend has been changing and the entry of new vehicles into the market is higher than the total increase in the number of vehicles so that the vehicle pool is being renewed.

If we compare these data with the data for the EU it becomes clear that in the EU countries the entry of new vehicles is much higher than the total increase of the vehicle pool.

It may be concluded from the above that the annual rate of vehicle pool renewal in the EU is higher than that in Croatia, while it amounts to around 6% for the EU and is on a constant rise for Croatia, already reaching an annual rate of 4% (Figure 12).

Lower rate of vehicle pool renewal in Croatia may be explained by the market's "hunger" for new passenger vehicles. By comparing market saturation with passenger vehicles in EU and in Croatia, we may observe that Croatia is on the level of 255 vehicles per 1000 inhabitants while the EU average is nearly double: 469 vehicles per 1000 inhabitants.

By analyzing the change in the average age of passenger vehicles in Croatia for the1993-2002 period one may observe by 1996 a speedy increase of the average age of passenger vehicles, i.e. as has been shown before that Croatia had a negative rate of vehicle pool renewal, while the trend has changed after 1996.

By comparing average age of passenger vehicles with the gross social product one may establish a certain correlation, and also the impact of the gross social product increase on the lowering of the average age of passenger vehicles and vice versa. For the period until 1996, GSP increase entailed also the increase of the average age of passenger vehicles because of the high rate of used vehicles import, mostly from Western Europe.

It is important to point out that even in the EU countries, regardless of the vehicle pool renewal annual rate of 6%, there is also the trend of vehicle pool ageing, only much slower than in Croatia. The EU average is around 7 years, while in Croatria it is around 11 years.

While considering the span of average age of passenger vehicles in the EU countries, one may observe end values for Portugal where changes in the age structure of passenger vehicles correspond to the values for Croatia, and, on the other hand, Luxembourg where the average age of passenger vehicles is the lowest in the EU: around 4 years.

Apart from the vehicle pool condition in Croatia shown so far, regarding the impact on the emission of exhaust gases, it is important to point out that the ratio of catalyzed and uncatalyzed gasoline engines is constantly changing. Thus, since 2001, when the share of catalyzed vehicles was 45%, it went up to 58% in 2003.

Since 2001, in the scope of technical verification of vehicles, ECO test is also being performed for gasoline engines, with results showing that the number of vehicles failing the Eco test becomes lower each year, especially as regards catalyzed vehicles, the decrease being from 47% of failing vehicles in 2001 to 30% in 2003. As regards uncatalyzed gasoline engines, given that they concern considerably old vehicles, the situation is much worse, and from 71% failing vehicles in 2001 we have arrived to the level of 63% in 2002, while in the course of 2003 there have been no considerable improvements. Since the ECO test has become mandatory as of 01 October 2004, the situation is bound to improve considerably, while it is also expected that the ECO test shall speed up vehicle pool renewal in Croatia.

Conclusion

1. Any considerable reduction of exhaust gas emission is possible only through the development of new automotive technologies.
2. Increasingly stringent requirements for fuel quality are the result of increased sensitivity of the exhaust gas processing system to individual physico-chemical properties of the fuel.
3. The vehicle pool age structure considerably limits the possibilities of reducing the exhaust gas emission.
4. Given the current situation in Croatia as well as the change trends of the basic vehicle pool characteristics, while ensuring fuel whose quality matches valid European specifications, there is a justifiable reason for keeping the lower quality fuel on the market in volumes dependent on market needs.

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UDK/UDC	Ključne riječi	Key words
658.8.011.1 : 665.73/.75	politika proizvonje i prodaje motornih goriva	engine fuel production and marketing policy
311.12 /.17 : 629.113.5	struktura i kretanje populacije vozila	vechicle population structure and movement
614.71	zaštita atmosfere, udio emisije motornih vozila u ukupnom zagađivanju	atmosphere protection, rate of vechicle emission in proportion of total pollution
504.3.054 : 665.73/.75	emisija iz motornih vozila zbog svojstava goriva	vehicle emissions due to fuel properties
504.3.054 : 621.43.019	emisija iz motornih vozila zbog svojstava motora	vehicle emissions due to engine properties

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